

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION

9 April 2024 (am)

Subject CM1 – Actuarial Mathematics for Modelling Core Principles

Paper B

Time allowed: One hour and fifty minutes

In addition to this paper you should have available the 2002 edition of the Formulae and Tables and your own electronic calculator.

If you encounter any issues during the examination please contact the Assessment Team on T. 0044 (0) 1865 268 873.

- 1** A company has been presented with two alternative business projects, A and B. The company must decide which of the two projects to invest in.

The projected year-end cashflows for the two projects are given in the 'Q1 Base' worksheet.

- (i) Calculate the internal rate of return for each project. [4]

The company sets an internal target for the rate of return at 4.5% p.a. effective.

- (ii) Calculate, for each project, the present value of the net cashflows at the target rate of return. [3]

- (iii) Calculate, for each project, the discounted payback period at the target rate of return. [6]

The company decides which project to invest in based on the internal rate of return, the present value of the cashflows and the discounted payback period.

- (iv) Explain, with reference to your answers to parts (i), (ii) and (iii), which project the company should invest in. [8]

[Total 21]

- 2** An endowment assurance policy is issued to a life aged 45 exact for a term of 20 years. Under this policy, the sum assured, payable at the end of year of death, is £10,000 for the first 10 years and £20,000 for the subsequent 10 years.

- (i) Complete the mortality table using the headings provided in worksheet 'Q2 (i)'. [3]

- (ii) Calculate the expected present value of the benefits. [8]

- (iii) Calculate the variance of the present value of the benefits. [5]

Basis:

Force of mortality $\mu_{45+t} = 0.03$ for all t

Interest rate 5% p.a. effective

[Total 16]

3 An insurance company sells a combined loan and decreasing term assurance policy to house buyers. Level premiums are payable annually in arrears to cover:

- the cost of the decreasing term assurance.
- the interest due on the loan.
- the repayment of the loan.

The 'Q3 Base' worksheet contains all the assumptions used.

A house buyer aged 32 exact purchases a 30-year policy with a loan of £200,000.

(i) Calculate the loan outstanding at the beginning of each policy year. [4]

At the beginning of each policy year, the sum assured for the decreasing term assurance is set equal to the loan outstanding at that time.

(ii) Calculate the annual premium for this policy. [14]

A colleague has pointed out a potential risk to the insurance company regarding the timing of premium payments in the first year.

(iii) Outline the problem. [3]

[Total 21]

- 4** A life insurance company offers 20-year unit-linked endowment assurances to lives aged 30 exact. Premiums of £2,000 p.a. are payable annually in advance for the term of the policy or until payment of any benefit if earlier.

The death benefit, payable at the end of the year of death, is the greater of £15,000 and the value of the units. On maturity, the value of the units is payable.

The assurance includes an additional critical illness benefit. On diagnosis of a critical illness, the value of the units is payable immediately and all cover ceases.

The level allocation rate is 95%.

The remaining policy terms and profit test assumptions are held on the 'Q4 Base' worksheet.

- (i) Calculate the unit fund value at the end of each policy year. [7]
- (ii) Calculate:
- (a) The dependent rates of mortality and critical illness for each year of the policy. [7]
- (b) The probability that the maturity benefit is paid. [2]

The company decides to set a new level allocation rate such that the present value of profits is equal to 10% of the annual premium. All other policy terms and assumptions remain unchanged.

- (iii) Calculate the new allocation rate. [24]
- (iv) Determine, without performing any further calculations, if the company should hold non-unit reserves for this contract. [2]

[Total 42]

END OF PAPER